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QWeCI

Quantifying Weather and Climate Impacts on Health in Developing Countries

Deliverable 5.3e: Open GIS Source software

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Lead contractor: CSE
Coordinator of deliverable: CSE
Evolution of deliverable

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Introduction

The QWeCI project (Quantifying Weather and Climate Impacts on Health in Developing Countries) funded by FP7 from European Commission is mainly focusing on how to evaluate the use and awareness of predictions and projections of atmospheric variability on time scales of weeks, months and seasons (weather), up to decades (climate) for quantification of health impacts in targeted countries. In Senegal, the WP 5.3 of QWeCI is dedicated to the pilot project, and this study is focusing in the Barkedji Health and Environment Observatory (figure 1).
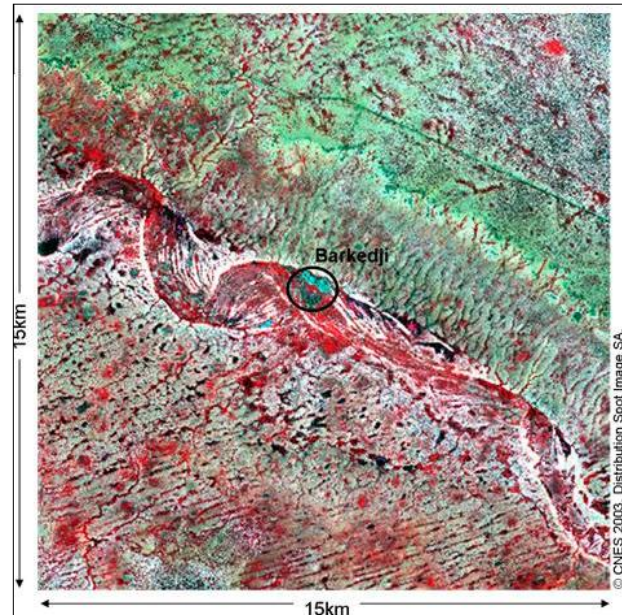

Figure 1: The Barkedji Health and Environment Observatory, study area of the QWeCI project in Senegal.

1. **Diseases under investigations**

Among vector borne diseases in Senegal, RVF and malaria are both strong concern of researchers and decision makers. With regards to the QWeCI project, the two diseases are under investigations, namely Rift Valley fever and malaria.

1.1-   Rift valley fever

Rift Valley fever (RVF) is an acute fever causing viral disease that affects domestic animals (such as cattle, buffalo, sheep, goats, and camels, among others), and humans. RVF is most commonly associated with mosquito-borne epidemics during years of unusually heavy rainfall events. The RVF virus, a member of the genus *Phlebovirus* in the family *Bunyaviridae*, is responsible for the disease. RVF was first reported among livestock by veterinary officers in Kenya in the early 1900s. Numerous epidemic/epizootic outbreaks have been reported periodically in many African countries during the past 30 years (Meegan 1979; Hoogstraal et al., 1979; Arthur et al. 1993; Jouan et al., 1988; Digoutte and Peters 1989; Zeller et al., 1997; Linthicum et al., 1999; Nabeth et al., 2001; Woods et al., 2002; Sissoko et al, 2009; Caminade et al, 2011; El Mamy et al, 2011). The virus has been recently located for the first time outside of the African continent, in Saudi Arabia and Yemen during 2000-2001 (Miller et al., 2002; Jupp et al., 2002).

In Senegal the RVF outbreak occurred in 1987 (Meegan et al, 1988; Jouan et al, 1989; Digoutte et Peters, 1989; Ndione et al, 2005). After this outbreak, entomological studies were conducted in Senegal from 1991 to 1996 to identify the sylvatic vectors of the virus (Fontenille et al., 1998). In 1998, following the re-emergence of the RVF virus in south eastern Mauritania and in the Diawara region, an entomological survey was undertaken at the northern border of Senegal to assess the extent of the virus circulation. During this study (Diallo et al., 2000) isolated the virus for the first time from *Culex poicilipes*.

Over Senegal and southern Mauritania, RVF epidemics (Ndione et al, 2003; Ba et al., 2005), do not seem to follow the same relationships as that over East Africa (Davies et al, 1985; Linthicum et al, 1999; Anyamba et al, 2001). The spatio-temporal distribution of discrete rainfall events (such as squall-lines) during the rainy/summer monsoon season (contrary to the seasonal amount of total rainfall over East Africa) appears to be the confounding parameter for mosquitoes' production (Ndione et al., 2003). In accordance with Bâ et al. (2005), Mondet et al. (2005), Ndione et al. (2008), rainfall frequency/periodicity (including timing of intra-seasonal variability) is a key factor modulating *Ae. vexans* population abundance.

Today, new scientific challenges have dealing with health early warning systems, including GIS and remote sensing (Lacaux et al, 2007).

1.2-   *Malaria*

Malaria is an anopheline-borne infectious disease of humans caused parasite of the genus Plasmodium. Five species of Plasmodium can infect and be transmitted by humans. The vast majority of deaths are caused by P. falciparum while *P. vivax*, *P. ovale*, and *P. malariae* cause a generally milder form of malaria that is rarely fatal. The zoonotic species *P. knowlesi*, prevalent in southeast Asia, causes malaria in macaques but can also cause severe infections in humans. Malaria is prevalent in tropical and subtropical regions because rainfall, warm temperatures, and stagnant waters provide habitats ideal for Anopheles larvae. Disease transmission can be reduced by preventing mosquito bites by distribution of mosquito nets and insect repellents, or with mosquito-control measures such as spraying insecticides and draining standing water.

Over the past five years, considerable efforts have been made for the implementation of effective control strategies. Thus, significant progress has been made in the control of malaria in Sub Saharan African countries. This success was attributed to the diversification of control measures used, the improved treatment and better diagnosis methods. However, the decrease tendencies were short-lived to have been disrupted by the recent "rebound effects" evidenced by a rapid increase in several contexts in sub-Saharan Africa. The hypotheses to explain this unexpected situation takes into account the loss of population immunity associated with climatic and environmental changes especially in arid areas. In fact, several studies suggest that climate change would lead to an increase in malaria cases since it is estimated that among the tropical diseases, malaria is the most affected by recent climate changes. These changes in the local physical environment (rainfall, temperature, water surface, humidity, vegetation, etc.) expected under different scenarios would affect the biology and ecology of vectors (survival, vector competence, etc.).

With regards to Barkedji, Lochuarn et al (1995), Lemasson et al (1997) and Dia (2007) described the malaria profile in this area thanks to fields studies; more recently, Dia et al (2010) gave some new findings dealing with land use and cover changes.

2. Open GIS HEWS

2.1- Identification of Geospatial layers

In the Barkedji Health and Environment Observatory (BHEO), different data have been collected since the beginning of the project. In fact, there is a high concentration of in-situ measurements in BHEO covering various sectors: climate, hydrology, water quality, vegetation, land use and land cover changes, veterinary survey (herd concentration, serosurvey, and location of ruminants' parks), malaria incidence, entomological, viral surveys and social pastoral practice's investigation.

In addition, before the QWeCI project, some other information were available in this area, and this platform will be an opportunity to pool and enhance all these valuable data. Two DMCs (Data conceptual model) are posted in annex to this milestone for illustrating two components of the HEWS conceptual model. In addition a screen capture of ArcView different layers are available also in annex.

The table below gives an overview of geospatial layers available.

Themes	Layers
Climate	Map of rain gauge network
Hydrology	Map of ponds (water bodies)
Water quality	Sites for water quality sampling
Land use and land cover change	Map of soils Land use
Veterinary survey	Herd concentration and location of ruminants' parks
Malaria incidence	Data available for the six pilot villages selected in the QWeCI project
Entomological sites	Sites where entomological captures are realised
Pastoral practices	Information dealing with transhumance, the length of their stay in Barkedji, the origin of their
Human settlements	Villages, cities, etc

2.2- Identification of tools

Two options of tools are available. The HEWS can be developed by using **Open source software** or it can be based on **Licensed software**, like ArcView or ArcGIS. Based on the experience that CSE had these last years, because we have developed several tools for our partners[1] like this one, it's better to do it with open source software. We take this choice because an open source tool can be handled more easily by stakeholders themselves, and they

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[1] CSE had developed several tools like this one for different projects in Senegal, like PRODAM, *Zones humides Ferlo (Wetlands in Ferlo area), INFOCLIM (Plateforme participative d'information pour l'adaptation des communautés vulnérables aux changements climatiques), PADERCA (Projet d'appui au développement rural en Casamance), BDU-Louga (Base de données urbaines-Louga)*

do not require the purchasing any license to run the software. In the other case if, it is developed using a software like ArcGis or ArcView, you need a license.

The software was developed with Delphi and TatukGis software and is an instrument for structuring and communicating information. The software was developed by the *Centre de Suivi Ecologique* (CSE). The instrument is equipped with the main functional characteristics of a GIS enabling the display of thematic layers and base already available as well as remote sensing data. The visual representation of data in the form of thematic maps is certainly easier to communicate than a set of tables and figures. Friendly and easy to use, the system has the characteristics specific to environmental monitoring: location, information about an object, data modification and pre-treatment in the form of thematic mapping spatial analysis and statistics.

It does not have all the computer components of GIS because it is limited to viewing the digital capture, and certain pre-programmed analyzes. The data below will structure the base: land use and land cover changes, socio-economy issues and health components.

2.3-   **Open GIS tutorial**

2.3.1- Installation

Copyright

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Requirement resources

This Open GIS needs windows® environment; at least 50 MB of free space on local disk.

Installation

For software installation, please double click on *setup.exe*, and follow instructions on the computer screen. It has been developed in French because the end user is the DSV (*Direction des Services Vétérinaires*, *National Livestock Service*). It will be easier for them to use it in French than in English.
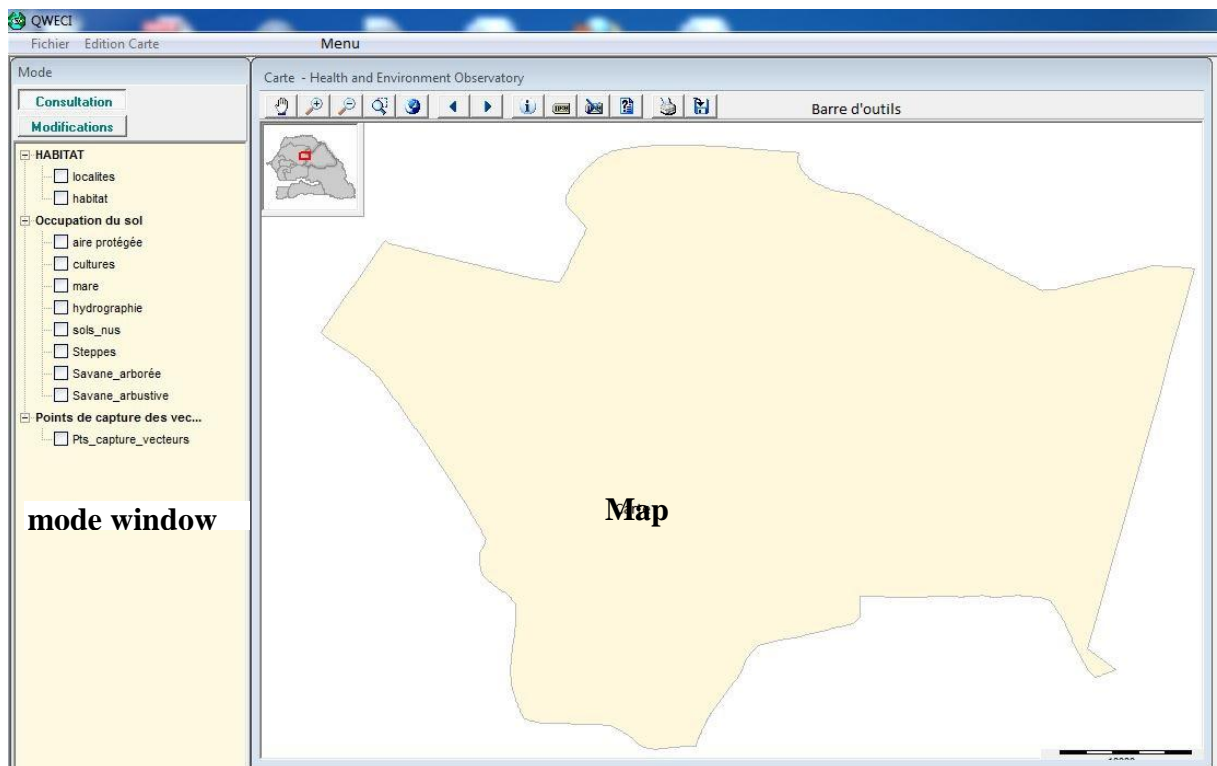
2.3.2- Start up

To launch the application: Start> Programs> Health QWECI year Environment Observatory
The main application window appears on the screen.

2.3.3- Navigation

The Open GIS SIG is structured in four components:
- □ the menu;
- □ the map;
- □ the toolbar;
- □ the window mode.

The menu

The menu bar allows to access to numerous functions:

Fichier (File)

- □ « *Quitter* » means « Leave » is for closing the programme or the software

Edition carte (Map edition)

- □ *Imprimer* (Printing), Starts the printing process of a map

- □ *Copier dans un fichier* (Copy file) Saves the map to an image file

Mode d'utilisation (Using mode)

This function allows you to choose a mode of operation of the two existing:

- *Consultation*   Access to data retrieval
- *Changes*   Adding, modifying or deleting data

The map

The map is the essential component of the software. Its size and position can be adjusted as needed during use.

The toolbar

The toolbar provides access to a set of navigation tools on the map

Icon	Name	Fonction
	Main (Hand)	Moving the map
	Zoom in	Enlargement of the map area
	Zoom out	Reducing of the map area
	Zoom box	Zoom in or out with the square designed by the cursor
	Refreshing	Return to the starting configuration
◀	Back	Back to previous view
▶	Forward	Back to the following view
	Information	Information on the data displayed
	Labels	Names of the displayed objects (labels)
	No label	Remove all labels
	General information	General information about the data layers
	Copy	Saving map to an image file
	Print	Start printing the map

The Window mode

Window mode appears at the far left of the screen. It changes depending on the mode selected for the selection of data or the type of change desired use.

2.3.4- Access to data

Data retrieval is done using the function proposed in the Consultation How to use menu. The mode window then shows the consultation mode.

The data is structured according to three themes:

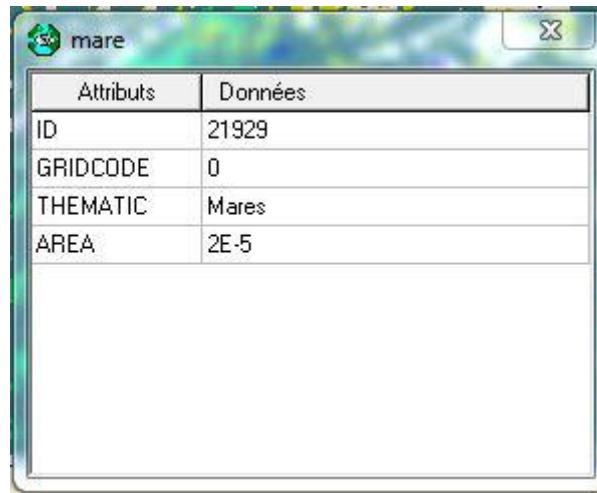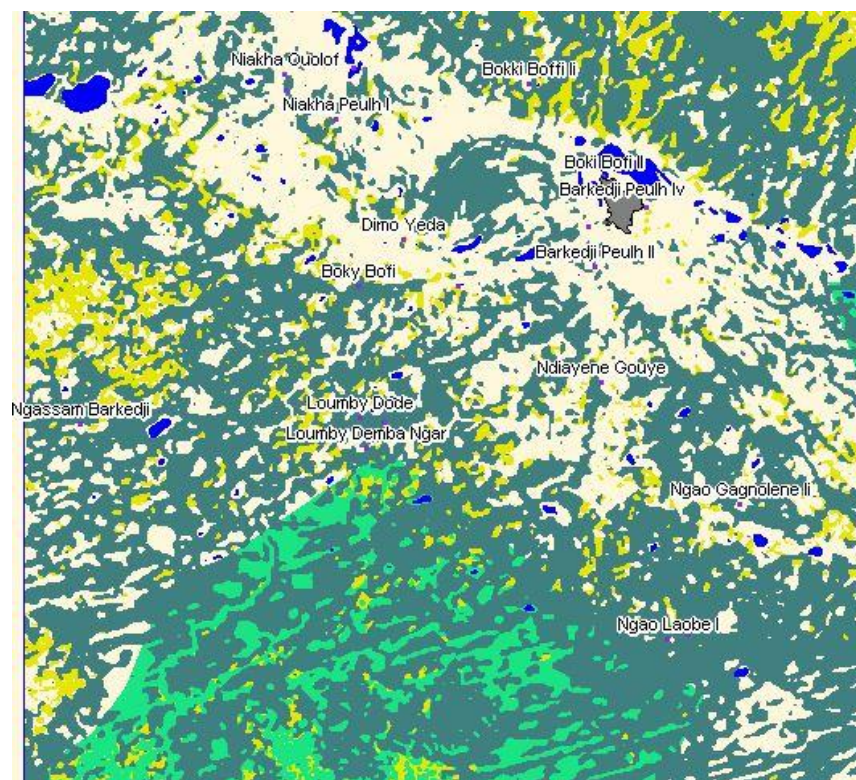|	
Habitat	**Habitat**
Occupation du sol	**Land cover**
Points de capture des vecteurs	**Sampling vectors' sites**

The display data is done by selecting the order named the corresponding data.

The displayed data appear on the map. We can then display the name of each object using the label tool.

You can also display a window associated with an object through information tool data.
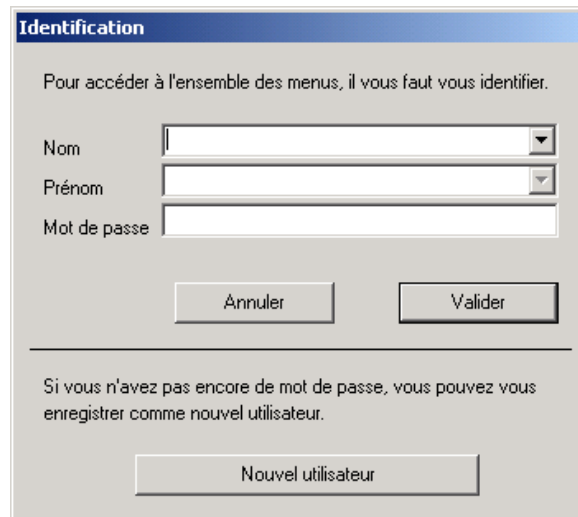

2.3.5- User registration

For all other uses other than a simple data consultation, the user is requested to register.

For new users, the registration is done through the "New User functions" (***Nouvel utilisateur, see screen capture above;*** only to perform at the first use).

For registered users, simply use the command OK after completing the identification fields.

2.3.6- Data modification

The modification of data is prepared by changing the operating mode menu function. The mode window then shows the edit mode.

The Edit mode allows five types of interactions:

- o Add new data
- o Modify existing data (correction or update)
- o Delete data (removal of erroneous data)
- o See the proposed amendments
- o Proposals and comments

Changes can be made by following the explanations that appear on the screen as and when required in window mode.

The changes proposed by a user do not directly influence the database. They are not visible through the consultation mode. These changes are actually collected by the manager of the database which will then verify the information and update the information contained in the software.

2.3.7- Technical support

For additional information, please contact

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Conclusion

The HEWS designed in the WP5.3 of the QWeCI project will give for local stakeholders but also for African health information systems, agencies and organizations over West Africa a panoply of additional products in support of appropriate measures to apply in regions under threats.

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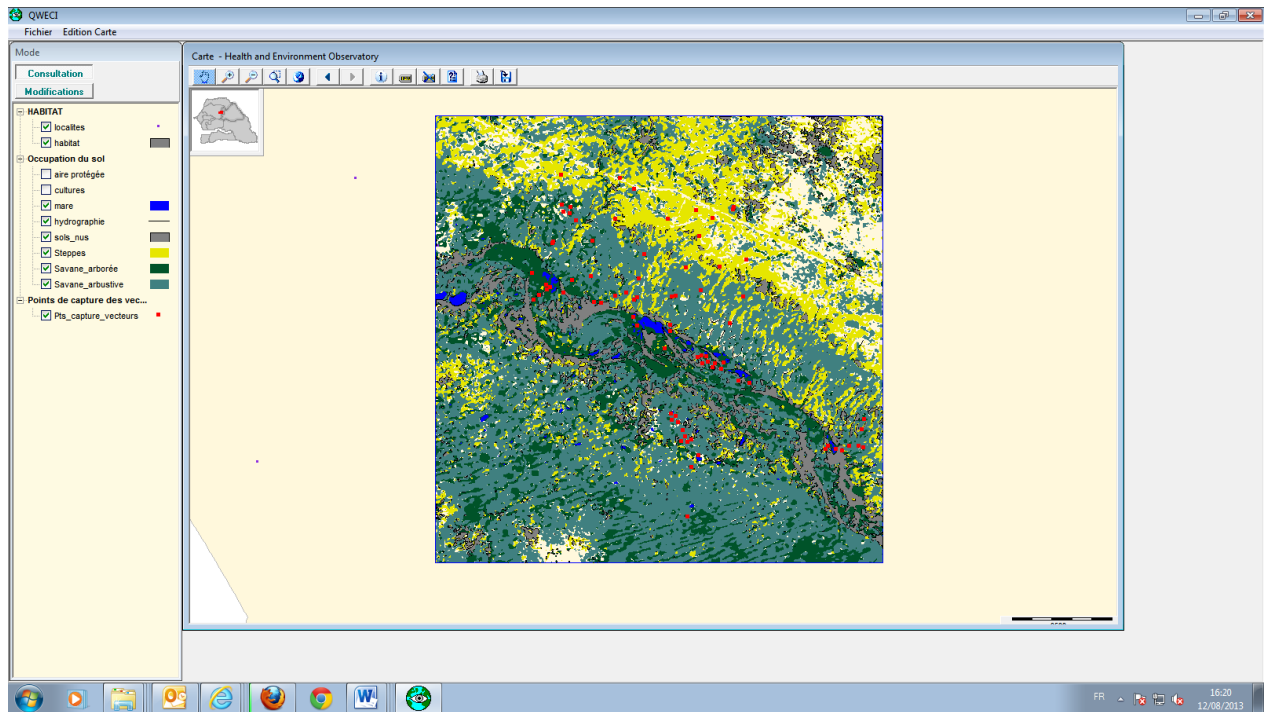
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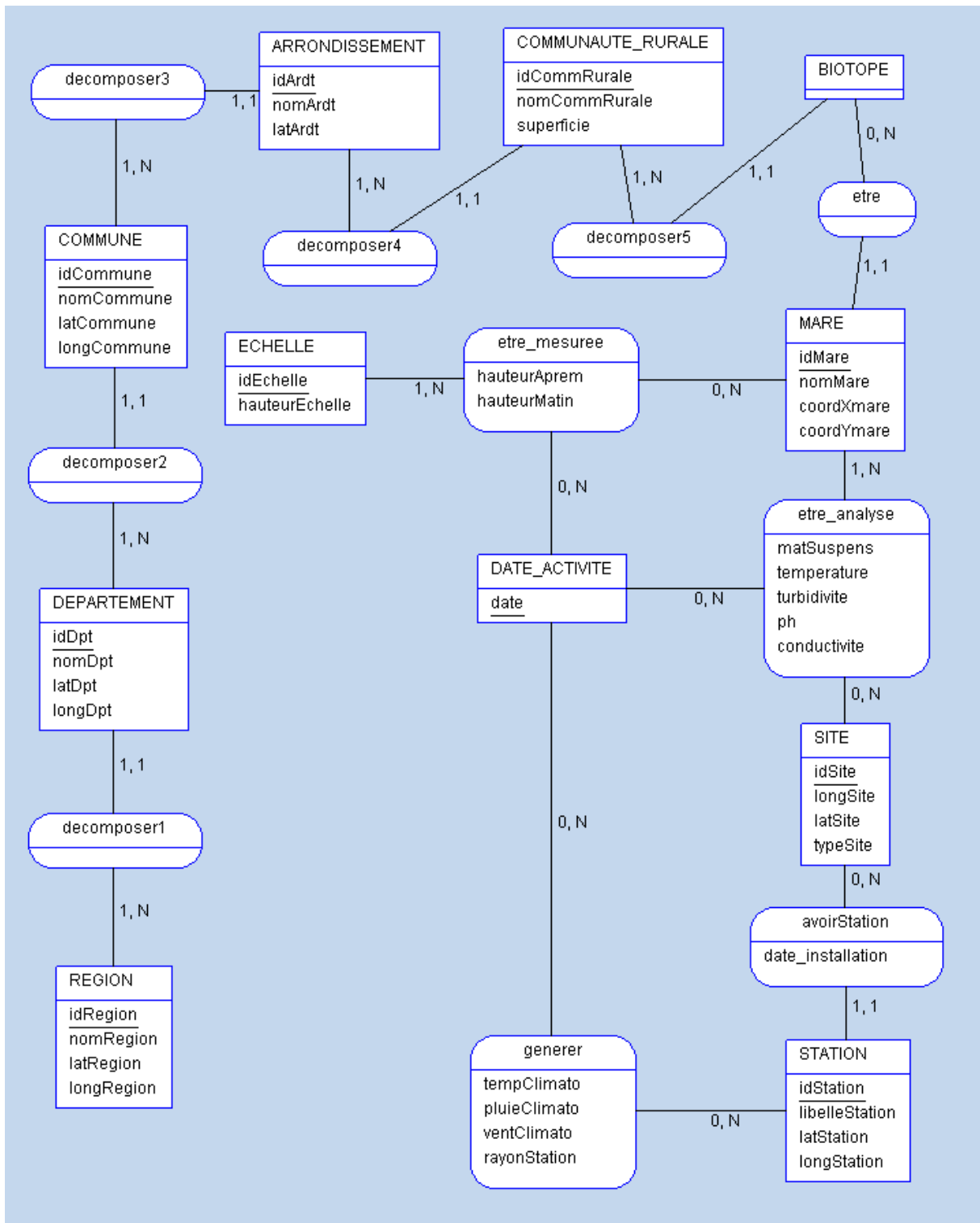
First step of DCM of climate and hydrollogical components of the HEWS
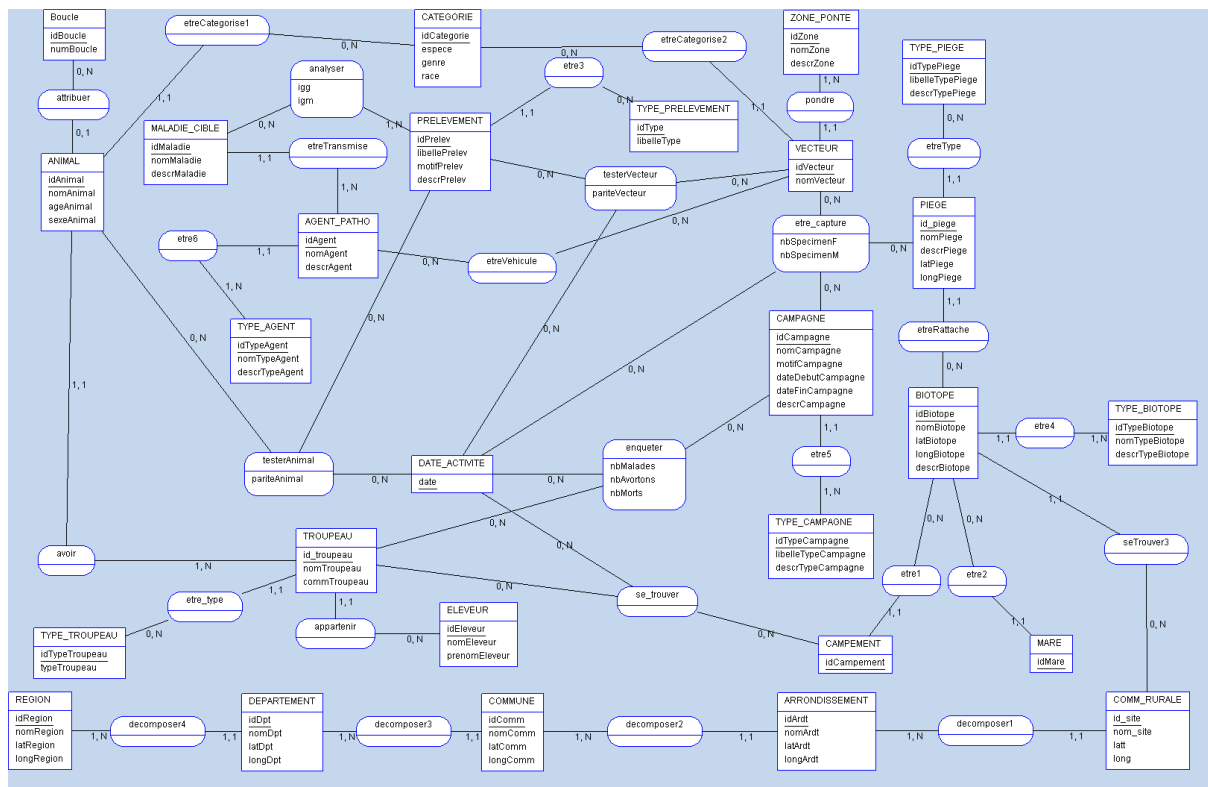
First step of DCM of entomological component of the HEWS

Screen capture of the Barkedji Health and Environment Observatory; information dealing with land use, ponds, entomologial sites (sampling vector sites).